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Report of the PSARC Salmon Subcommittee Meeting April 27-May 1, 1998 and the Steering Committee Meeting May 4, 1998

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PACIFIC STOCK ASSESSMENT REVIEW COMMITTEE

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PACIFIC SALMON

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I. STEERING COMMITTEE REPORT

The Steering Committee met May 4, 1998 at the Pacific Biological Station to review the Salmon Subcommittee report. The Steering Committee accepted the Subcommittee report with the following comments.

Major Steering Committee Discussion and Concerns

The Steering Committee advises the application of extreme caution in applying forecasts of coho abundance in 1998. Recent trends in marine survival have been below forecasts and marine conditions during 1997 were exceptionally poor. The returns to many wild coho populations for 1998 are expected to be below 3 females/km and 2 major stock aggregates are at critical conservation levels.

The Steering Committee advises that the **Upper Skeena and Thompson River** coho stock aggregates are extremely depressed, will continue to decline in the absence of any fishing mortality under current marine survival conditions, and that some individual spawning populations are at high risk of biological extinction.

The Steering Committee advises that the forecast of marine survival for 1998 for the **Upper and Lower Skeena** may be overly optimistic and caution is advised. The Steering Committee noted with concern that the **Lachmach coho indicator stock** substantially overestimated survival in 1997. The overall Skeena problem is made more serious by the evidence that Upper Skeena survivals in 1997 were even less than those associated with the indicator (Lachmach).

The Steering Committee advises that the majority of coho streams in the **Strait of Georgia and Lower Fraser River** will not reach 3 females/km in 1998 even in the

absence of fishing mortality. This stock aggregate is deteriorating rapidly under current marine survival conditions and extreme caution is warranted for this stock aggregate.

Similarly, under the anticipated low marine survival, many **WCVI** coho streams are not expected to achieve 3 females/km even in the absence of fishing mortality. In particular, conservation concerns were noted for Statistical Areas 21 and 22.

The status of **Central Coast** coho is uncertain although potential conservation concerns have been identified in Statistical Areas 5 and 6.

The Steering Committee recommends that the status of fresh water coho habitat be summarized. The PSARC Habitat Subcommittee should be tasked with identifying the parameters to be measured and the geographic extent of the program and resources required as one of its first priorities. Results should be analysed in conjunction with results from the wild stream indicator program to better understand the role of habitat availability and trends on freshwater survival rates.

The Steering Committee notes that any non-retention fishery that catches coho (e.g., selective mark fisheries) will confound natural mortality with incidental fishing mortality in 1998; this would be a new source of unquantified fishing mortality. The Department must evaluate the potential impact of mark selective fisheries on the assessment of any threatened wild coho stocks (e.g. Thompson River coho).

The Steering Committee endorses the review of the objectives and design of the **coho fry survey programs.**

The Steering Committee endorses the addition of **wild coho indicator streams** for the highest priority coho aggregates (e.g. Upper Skeena).

The Steering Committee notes that an inter-branch team has been formed and will be conducting a review of **regional escapement needs**.

The Steering Committee supports the evaluation of the role **enhancement** might play in rebuilding small, depressed coho populations. The Steering Committee requests a thorough review of the role and potential **impact of coho enhancement on wild stocks in the Upper Skeena and Thompson River**. This is a high priority issue and is required to support the salmon policy development.

The Steering Committee notes that the **Cowichan chinook stock** is rebuilding as the result of enhancement and reduced exploitation rates. The Steering Committee recommends an evaluation of the level of enhancement utilized to sustain production in the "Cowichan River". A full assessment of the Lower Georgia Strait (LGS) complex would require funds to undertake the assessment in the Squamish drainage.

S98-7 Assessment of west Vancouver Island coho, 1997.

The Steering Committee notes that:

- Marine survival is variable and non-trending.
- Escapement was above average in 1995, average in 1996 and below average in 1997. However, 1997 escapement was well above the 1994 brood year escapement.
- There was a significant reduction in exploitation rate on WCVI coho in 1997.
- There were conservation concerns expressed for coho stocks in Statistical Areas 21 and 22. However, further analysis is required to clarify this concern due to uncertainty in the data.

S98-8 Estimating the percentage of hatchery-reared juvenile coho salmon in the Strait of Georgia.

The Steering Committee notes that the proportion of coho of hatchery origin in the Strait of Georgia is consistent with current assessments of the extremely low abundance of wild stocks.

S98-9 Forecasting coho marine survival using the regime concept.

The Steering Committee had no comment.

S98-11 Rivers Inlet sockeye salmon: stock status update.

The Steering Committee accepts the recommended forecast and notes that:

- The low returns in 1995 and 1996 were likely the result of poor marine survival.
- Due to recent low escapements in 1995 and 1996, poor returns are expected through the year 2000.
- 1997 escapement increased but remained below the long-term average.

S98-12 A risk assessment for north coastal coho fisheries in 1998, with commentary on risk in southern inside and outside fisheries.

The Steering Committee notes that Upper Skeena coho stocks are extremely depressed, will continue to decline even in the absence of any fishing mortality and are at immediate risk of biological extinction.

The Steering Committee further notes that :

- Spawning escapement in the Babine Lake coho aggregate has declined from a range of 20,000 to 100,000 coho in the mid 1960s to 469 in 1997 (i.e. less than 1% of the historical average). In terms of females/km these numbers translate to approximately 25 females/km in the 1960s, 3 females/km in 1990-1996 period, and 0.3 females/km in 1997.

- In the Upper Skeena coho stock aggregate, 40% of the streams are not expected to achieve one female per km in 1998.

The Steering Committee agrees with the Subcommittee recommendations that if marine survival does not improve, populations will likely continue to decline even in the absence of fishing mortality. Risk of extinction increases exponentially with decline in populations size.

The Steering Committee agrees with the Subcommittee that further work should be done to clarify the escapement estimates in Statistical Areas 5 and 6.

The Steering Committee notes for Strait of Georgia/Lower Fraser River and WCVI:

- Deteriorating stock status due to poor marine survival.
- The majority of the surveyed populations will be below the minimum conservation objective (3 female/km).

In addition the Steering Committee is concerned about the very warm ocean waters that juvenile coho entered in 1997 (at least 3 Standard Deviations above average). These are the fish that will return in 1998.

S98-13 Stock assessment of Thompson River/Upper Fraser River coho salmon.

The Steering Committee notes that the total returns and spawning escapement of coho in the North and South Thompson River have declined to record low levels over the last 10 years.

The Steering Committee also notes that there has been a decline in the reproductive potential of Thompson coho. In 1997 there was a preponderance of males in the escapement, and a decline in the average size of females and their associated fecundity.

S98-15 Stock status of Cowichan chinook salmon.

The Steering Committee supports the Subcommittee's recommendations.

S98-17 Dynamic change in proportion of hatchery-reared, wild ocean and stream type chinook in their first and second years in the Strait of Georgia.

Steering Committee has no comment

S98-18 A risk assessment for Thompson River coho salmon.

The Steering Committee notes that:

- Coho salmon populations of the Thompson River drainage have been declining at a rate of 50-70% per generation since 1988.

- Escapements to the enhanced Eagle and Salmon River populations have declined to 1-2% of the 1988 escapement levels.
- Many streams have declined to "no observed" status within three generations (1988-1997).
- The cause of the decline is a combination of poor marine survival and recruitment overfishing. A full assessment of freshwater survival has not been completed.
- This information points to a conservation crisis that includes substantial risk of biological extinction.
- Fishing mortality will increase the rates of decline in these populations and will increase the risks of extinction.

II. SALMON SUBCOMMITTEE REPORT

1. Introduction

The PSARC Salmon Subcommittee met April 27-May 1, 1998 at the Pacific Biological Station, Nanaimo. Twelve working papers were presented to the Subcommittee. Meeting participants and reviewers of working papers are listed in Appendices 1 and 2, respectively.

The previously reviewed West Coast Vancouver Island chinook forecast for 1998 is appended (Appendix 3).

2. General Subcommittee Discussion and Concerns

Concerns over Coho Stock Status

The Subcommittee recommends that extreme caution be used in 1998 Pacific fisheries that encounter coho salmon. Upper Skeena and Thompson coho are extremely depressed and under the current climatic regime are expected to continue to decline even in the absence of fishing mortality. Since extinction risk increases exponentially with decreasing population size, the Subcommittee advises that the risks associated with fishing mortality are substantial. Although the magnitude of the risk cannot be precisely quantified, the Subcommittee is certain both that the risk will increase as population sizes fall below their already very low levels and that the need for corrective action will increase correspondingly.

The status of the Strait of Georgia and Lower Fraser aggregate is also deteriorating due to continuing poor marine survivals. With current forecasts of continuing poor marine survival, fishing mortality will delay recovery. Although depressed, the majority of stocks in this area are not yet at the critically low levels prevalent in the interior. The Subcommittee emphasizes that the necessary corrective actions will become more stringent. As populations decline the likelihood of the success of these corrective actions will fall. The Subcommittee therefore advises that extreme caution is warranted for this stock aggregate.

For the west coast Vancouver Island aggregate, the Subcommittee advises that exploitation rates of less than 30% are required to ensure that escapements to most streams will reach levels of more than 3 females/km.

For the Lower Skeena aggregate the Subcommittee notes that although at 1997 exploitation rates (50%-60%) most streams would be expected to achieve 3 females/km. The Subcommittee advises that this forecast be treated cautiously since similar forecasts for 1997 did not predict the observed recruitment failure.

Selective Fisheries

The Salmon Subcommittee is concerned about a potential limitation to our abilities to evaluate management actions taken to conserve the Thompson River coho stock in 1998. Most importantly, the report by the Ad Hoc Selective Fishery Evaluation Committee (PSC 1995; review by PSARC, Rice et al. 1996[1]) notes that one of the most significant impacts of implementing mass marking and selective fisheries will be on the assessment of wild coho populations. Assessment of total exploitation rates and marine survival for a wild coho population could not be estimated *unless the population is associated with a mass-marked and double-index tagged hatchery coho stock*. This hatchery stock should be from the same geographic region and have the same ocean exploitation pattern to be representative of the associated wild population. The independence of our wild coho stock monitoring programs (i.e., independence from relying on other hatchery stocks) will be lost; but without this association, the assessment of the wild coho population will not be able to directly estimate the marine survival of the brood years, the total exploitation rate on the brood if subjected to a selective fishery, or the distribution of incidental fishing mortality between fisheries.

Such tagging and recovery programs have not been implemented. Consequently information presently derived from the coded-wire tag program will be lost if selective fisheries for mass marked coho salmon are implemented in 1998. Selective fisheries may be limited to the selective retention of ventral-fin clipped coho salmon (mass mark applied to most Canadian hatchery coho salmon from the 1995 brood year) and we would expect significant misidentification of the mass mark in the first year of the selective fishery program.

The impact of this loss of information will depend upon the exploitation rate imposed by the selective fisheries. If the harvest rate is very low or the stock is rare in the fishery, the impact will likely be minimal. However, if the stock experiences any selective fishery mortality, then the assessment of all other fishery impacts becomes more uncertain and values for survival or exploitation rates will be underestimated.

Selective mark fisheries have implications for wild coho assessments throughout the region. In the Thompson River opportunities for double index tagging are rare and were

[1] Rice J., et al. 1996. Pacific Stock Assessment Review Committee (PSARC) Annual Report for 1995. Can. Man. Rep. Fish. Aquat. Sci. 2383: iv + 242p.

not implemented for a 1998 selective fishery. The Subcommittee is concerned over any erosion in our capacity to estimate marine survival for wild stocks. Double index tagging programs are required to minimise the impact of selective fisheries on the assessments of wild coho salmon populations. Monitoring of marine survival has been paramount in assessing the status of coho salmon and is a critical element of any future risk assessment.

Juvenile Surveys

The Subcommittee recommends that a review of the objectives and design of fry survey programs be conducted prior to their application in 1998 to ensure their utility within the assessment framework for coho salmon in this region.

Wild Indicator Streams

A wild indicator stream is a non-enhanced stream where adults and smolts are counted. Usually in-stream survival, growth and habitat use of juveniles are also quantified. The importance of wild indicator streams is fully discussed in S97-13[2], but there are five important reasons why these intensive projects are vital to assessment of coho salmon:

1. They provide high precision status indicators.
2. They provide smolt counts that are used to determine freshwater productivity, and separate the relative effects of freshwater and ocean climate variability.
3. They allow the application of CWTs and their recovery in escapement for measures of marine survival, exploitation rates and ocean distribution of wild fish.
4. They provide opportunities to calibrate productivity measures for application to surrounding systems in "extensive" areas, e.g. calibration of productivity measures used in juvenile work.
5. They provide the continuity that is important for the investigation of freshwater and marine productivity questions, life-history variation.

The Subcommittee notes that these kinds of information are lacking and that lack compromises the credibility of current assessments.

Currently three of the highest priority requirements are:

- Upper Skeena and the Thompson: Both of these are in the interior where there is an urgent requirement to not only provide more credible monitoring and assessment of coho but also an urgent need to improve our understanding of coho biology and life history variation in environments very different from those on the coast.
- Central Coast: There is virtually no credible information about coho status on the Central Coast but there are concerns about the status of coho in some areas. One

[2] Holtby et al. 1997. An Assessment Framework for coho salmon in the Pacific Region. PSARC Working Paper S97-13.

possibility that has been identified is Hooknose Creek in SA8 where there is past data and potential to develop a multi-species indicator (coho, sockeye, and pink).

There are other indicator stock needs as well: mainland side of the Strait of Georgia and Northeast and Northwest Vancouver Island.

Escapement Data Quality Issues

The Subcommittee is concerned with the apparent erosion of the utility of the coho escapement data for some areas because of changes in the escapement methodologies, largely due to reduced survey effort. The issue was raised with respect to Statistical Area 5, but there is a more widespread base of concern. In some cases, assessments of the data could clarify the utility of the historical data. These concerns reinforce the need for a regional review of this and other escapement data issues.

Enhancement Impacts

The Subcommittee discussed the impacts of enhancement on a rebuilding salmon stock, the Cowichan River chinook, as well as the impacts of enhancement in severely declining coho stocks, e.g. the Thompson and Upper Skeena coho. The Subcommittee suggests a PSARC paper be prepared on the role of enhancement in the conservation of salmon stocks, particularly during this period of critically low coho abundance.

3. Working Paper Summaries, Reviews and Discussion

S98-7 Assessment of west Vancouver Island coho, 1997. K. Simpson.

Working paper accepted subject to revisions

Working Paper Summary

This is the second PSARC working paper assessing the status of coho salmon stocks on the west coast of Vancouver Island (WCVI). The first, S96-10, reviewed their status up to 1995. This report's objective was to use 1996 and 1997 data to re-examine trends in fry, smolt and escapement abundance in relation to catches, marine survivals and exploitation rates.

Over 90% of the coho in this area rear in freshwater for one year. The proportion of age 2 smolts is less in streams lacking a heavy canopy, e.g. logged watersheds, and is especially small when fry are growing well in response to low densities. Thus, the extensive logging in this region may have reduced life history variability so impacts on a year class are less buffered.

West Vancouver Island coho tend to remain in the WCVI area. The vast majority of catch was in the WCVI troll fishery until 1997 when this fishery was completely closed for coho retention to conserve southern BC coho. This action and a greater than normal

northward dispersal resulted in an unusual but not unprecedented proportion of recoveries north of Vancouver Island (38% for Robertson Creek Hatchery coho). Most of the remaining recoveries were in local sport fisheries, not including the Juan de Fuca sport fishery where few WCVI coho recoveries occur.

Recent escapements are marked by the extremely low escapement in 1994, the result of near zero survival of smolts that went to sea in 1993. Although data from the northern portion of Vancouver Island are uncertain, WCVI escapements were probably above the 25 year average in 1995, about average overall in 1996 and below average in 1997. However, the 1997 return was a marked improvement over the critically poor 1994 brood year escapement. A significant regression of parental escapement on fry density from Carnation Creek was used with fry densities from an extensive sample of WCVI streams to estimate their female escapements from 1994 to 1996. Average female escapements estimated this way were 13, 30 and 31 per kilometre. However, 1994 escapements to indicator stocks were worse than to the average fry survey stream (assuming this estimation method was accurate). The decreased 1996 escapement to indicator stocks was not apparent in the fry survey streams. This report gave greater weight to the observed escapements from indicator streams, primarily Stamp River, Carnation Creek and Gold River. One reason was the coherence of data, e.g. the long time series from Gold River and Carnation Creek are significantly correlated.

Data from Carnation Creek which is the main indicator stock for WCVI suggests that the 1997 escapement was in large part due to excellent fry survival. Fry surveys showed that the sparse fry in 1995 were growing well throughout west Vancouver Island. Size and survival were positively correlated. The 1997 return can also be credited to a reduced exploitation rate, down by half to 31.5% for Robertson Creek Hatchery coho.

Marine survivals of Robertson and Carnation coho have trended down since the start of records in the early 1970's. The trend was broken by a period of relatively good survivals from 1989 to 1992. 1.7% and 3.5% of Robertson Creek Hatchery smolts returned in 1996 and 1997 compared to the long term average of 4.3%. The survival of Carnation coho, assuming an exploitation equal to Robertson Hatchery coho, was 5.3% for the 1993 brood year class and will be at least 11.2% for the 1994 brood year class. The average survival of Carnation coho is 12.6%.

Escapement data (acknowledged to be of uncertain accuracy) and low fry abundances indicate there is a continuing conservation problem in Areas 21 and 22.

Reviewers' Comments

Reviewer #1

The first reviewer pointed out the difficulty of assessing such a large aggregate of stocks with the limited data available. However, the reviewer commended the author for preparing a clear and concise document that properly described the data and methods used. The reviewer noted that the conclusions were supported by the data. This

reviewer agreed with the recommendations of the author but felt that more details were needed, particularly in describing the Area 26 or 27 indicator stock program.

Reviewer #2

The second reviewer felt the paper generally accomplished the goal of assessing the 1997 return of WCVI coho stocks. This reviewer did however, raise a number of concerns which included; (a) use of Robertson Creek hatchery CWT data to represent the catch distribution of Carnation Creek coho (a wild indicator stock), (b) the effect of fishery management actions on catch distribution, (c) utility of fry estimates as surrogates for escapement data. The second reviewer supported the recommendations as written but pointed out the need for careful consideration of how Robertson Creek Hatchery CWT data are applied to Carnation Creek returns.

Both reviewers concurred with the author that a review of the design of the fry survey program is warranted given the non-random nature of site selection for these surveys.

Subcommittee Discussion

The Subcommittee accepted the working paper subject to revisions. The Subcommittee noted the rapid increase of WCVI coho populations in 1997 from the disastrous escapement in 1994 and agreed with the author that the increase was due to a favourable combination of:

1. High freshwater survival resulting from low seeding densities and compensatory growth of juveniles;
2. Near average marine survivals; and
3. Much reduced fishery exploitation rates.

The Subcommittee shared concerns expressed by the reviewers about the lack of random site selection for the juvenile surveys. The Subcommittee also felt that the fry survey sites should be geo-referenced to facilitate the use of the data by others. In spite of this short-coming, the fry surveys instituted in 1995 identify low fry abundances in 1995 resulting from the low escapements in 1994 (as indicated by the escapement indicators).

There was some discussion about the completeness of the Robertson Creek Hatchery CWT escapement estimates since tagged fish are only enumerated at the hatchery with no consideration of straying to the natural spawning grounds. Natural spawning ground surveys were done in the early years of the Robertson Creek Hatchery project and virtually no tagged coho were recovered. Nevertheless, the Subcommittee felt that a repeat of these surveys was warranted given the time that has elapsed and the importance of the Robertson Creek hatchery as an exploitation rate indicator stock. Over time, Robertson Creek exploitation rates appear reasonable relative to Strait of Georgia exploitation rates, i.e. 10 to 20 percentage points lower. Tagged fish spawning in the wild is not believed to be a large problem but remains a source of some uncertainty.

The Subcommittee noted the variable, non-trending pattern of marine survival for WCVI coho which is in sharp contrast to the low downward trend for Strait of Georgia stocks. This is even more noteworthy when one considers that the situation in Washington State is the opposite; i.e. marine survival rates for Washington coastal stocks have declined to extremely low levels (1-2%) while Puget Sound marine survivals are in the 5-10% range.

Coho stocks in Area 21 were identified as a potential conservation concern in the working paper. The Subcommittee believed that there is cause for concern (although the current data is uncertain) and that a further detailed analysis of stock and habitat status, and potential fishery impacts on these stocks should be undertaken.

The Subcommittee supports the need for additional wild indicator stocks with associated CWT programs on the west coast of Vancouver Island, with the priority in Area 26 or 27.

Subcommittee Recommendations

The Subcommittee recommends that the impacts of hatchery mark selective fisheries on WCVI assessment programs (current and proposed) be evaluated. See General Subcommittee Concerns for further discussion.

S98-8 Estimating the percentage of hatchery-reared juvenile coho salmon in the Strait of Georgia. R.J. Beamish, R. Sweeting and Z. Zhang.

Working paper accepted subject to revisions

Working Paper Summary

The marking of a large number of hatchery coho in 1997 by removal of the left pelvic fin provided an opportunity to estimate the percentage of hatchery and wild coho in the Strait of Georgia. The survey of juvenile coho abundance and distribution in the Strait of Georgia and Puget Sound in 1997 provided samples that enabled estimates of hatchery and wild coho to be determined prior to any fishery. Using these marked coho and catches from surveys in June/July and in September, the proportion of juvenile hatchery coho within the Strait of Georgia ranged from 64-67%. If estimates of smolts from naturally spawning hatchery adults were included as hatchery releases, estimates of hatchery percentages in the catch could be as high as 75%. Both hatchery and wild juvenile coho remained within the Strait of Georgia until after September, several months after coho left Puget Sound. There was no difference in the length of coho with or without the left pelvic fin.

Reviewers Comments

Reviewer #1

Reviewer #1 found this paper to be straight forward in presentation of data and results but would benefit from additional analyses of the data provided and the inclusion of additional

data from CWT recoveries and release information from B.C. and U.S. hatcheries. The reviewer had numerous concerns and questions regarding the catch and hatchery release data and sampling design which need to be addressed as they are potentially significant to the papers results.

Reviewer #2

The reviewer suggested that inclusion of the progeny of hatchery origin adults which spawn naturally, with the hatchery reared releases is controversial. The main issue is the high proportion of Strait of Georgia fish that originate from a few stocks, not whether they are enhanced. The reviewer noted that enhanced contributions in 1997 need to be put in the context of other years. A number of points regarding release information, mark mortality, escapement, sample size and otolith results were also provided.

Subcommittee Discussion

Subcommittee discussions considered the impacts of the lack of a detailed description of the trawl survey sampling design (S98-14) on this paper. It was noted that the data presented in this paper appeared to be robust enough that the conclusions were not as dependent on review of the sampling design. The data were limited to the percentage of hatchery composition of the samples and it was felt the data could be accepted with some additional statistical support.

The Subcommittee discussed the issue of contribution of second generation hatchery fish. The paper refers to them as enhanced fish in the calculations, which tends to elevate the percent composition. The Subcommittee suggested that the second-generation hatchery fish remain in the calculations but be referred to as coho produced from a previously enhanced stock and not identified specifically as enhanced.

Subcommittee Recommendations

The high proportion of hatchery stocks is consistent with the current assessments of extremely low abundance of wild stocks. The Subcommittee recommends that this paper be accepted subject to minor revisions relating to inclusion of work done previously relating to this topic and additional statistical analysis such as boot strapping along with the inclusion of statements of uncertainty.

S98-9 Forecasting coho marine survival using the regime concept. R.J. Beamish, D. Noakes, G.A. McFarlane, W. Pinnex, R. Sweeting, J. King and M. Folkes.

Working paper accepted subject to revisions

Working Paper Summary

Regimes are persistent trends in a biological or physical time series that can shift abruptly

from one state to another. It is this persistence that may provide a useful way of forecasting trends in a related series. There is a relationship between the cumulative sum of the standardised anomalies of survival of hatchery-reared coho salmon released into Puget Sound and the total April flows from the Fraser River. Using this relationship for the regime that started after 1989, the authors concluded that the marine survivals in 1997, 1998, and 1999 are not likely to improve. The relationship with April flows is similar for the marine survival of hatchery-reared coho in the Strait of Georgia indicating that the trend in low marine survivals in 1998 and 1999 may continue or become worse. Data on ocean survivals of coho off Oregon show trends similar to Puget Sound and the Strait of Georgia. Thus, it is forecasted that the marine survival of coho at the southern limit of their distribution may not improve until at least the catch year 2000.

Reviewers' Comments

Reviewer #1

The reviewer stated that this paper is not an explanation of trends in marine survival that has been seen in the 1990's or why they have changed, but is a useful first step in providing some advice towards managing southern B.C. coho. The reviewer felt that the paper provided fairly compelling evidence of widespread and roughly synchronous changes in coho survival from Strait of Georgia, Puget Sound and the Oregon Production Index (OPI) area. Further, the paper presented a reasonable indication of the direction of marine survival over the next few years. The paper also possibly provides a methodology for marine survival trends a year in advance of the current forecasting methodology. The reviewer cautioned that one needs to be careful in the use of climatic time series as an indicator of survival when a mechanism that explains the link between climatic changes and survival is lacking.

Reviewer #2

The Reviewer agrees with the authors that there appears to have been a general decline in coho marine survival for all three production areas examined; Strait of Georgia, Puget Sound and OPI. It would also be relevant to speculate whether some "shift" occurred about 1990 to a different regime. The reviewer questions the use of simple linear regressions between river flow and coho marine survival. He pointed out that experience has tended to make managers skeptical about predictions based upon such simple correlations. While the reviewer found the paper stimulating, it may be mixing two themes with very different time scales; the non-linear regime concept and a linearized forecast. Both are important, but may not belong together.

Reviewer #3

This reviewer concentrated on evaluating the paper in the context that it was a forecast paper as indicated in the title. It was noted that over the last few years PSARC Salmon Subcommittee has created a set of standards that are to be used by authors of papers that concern forecasting methodologies. These standards include:

- a description of the data used;
- an explicit description of the model;
- explicit forecast with confidence limits at fixed probability levels;
- a retrospective analysis to objectively select among a set of forecast models.

The reviewer went on to state that more than one forecasting method is especially important if changes from past forecasting procedures for a stock or stock aggregate is in question. The reviewer recommended that the Subcommittee not accept the paper.

Subcommittee Discussion

The Subcommittee accepts the paper with revisions. The Subcommittee noted that the paper was not a forecast in the traditional PSARC sense, which explicitly forecasts survival with confidence limits and a retrospective analysis to allow selection among various forecast models. The authors presented a hypothesis that the downward trend in coho marine survival is linked to a regime shift that occurred in 1989. The Subcommittee expressed concern that the current version of the paper may not accurately capture that relationship and requested two main revisions to the paper. Firstly, the authors were directed to explicitly clarify the intent and purpose of the paper. Secondly, the Subcommittee asked the authors to explore the use of other models that may more accurately capture the trend in coho marine survival. One of the reviewers noted that oscillation models rather than a step function would be a useful alternative model to explore.

The authors clarified to the satisfaction of the majority of the Subcommittee that the paper could be revised to address the concerns raised by the Subcommittee. The discussion with the authors clarified that the revised paper would not be a PSARC forecast document. The authors were encouraged to work with interested members of the Subcommittee on specific revisions, and the authors encouraged Subcommittee members to submit any further specific concerns to the authors.

Subcommittee Recommendations

The Subcommittee made no recommendations at this time.

S98-10 Abrupt declines in the recreational catch of coho salmon in the Strait of Georgia in the 1990s are related to changes in climate. R.J. Beamish, G.A. McFarlane and R.E. Thomson.

**Working paper not accepted **

Working Paper Summary

The percentage of Strait of Georgia coho caught in the Strait of Georgia or off the west coast of Vancouver Island was determined from coded-wire tagged hatchery-reared coho

and varied from year to year. The variation was associated with the flow of fresh water from the Fraser River and became more extreme in the 1990s. In 4 of the 8 years in the 1990s, and in the past three years, most coho have been caught outside of the Strait of Georgia. The movement offshore was related to a lowering of the surface salinity in the Strait of Georgia, particularly in the winter. The change in salinity was related to an increase in the number of days of zonal (westerly) winds in October, November, and December and with an increase in relative sea level height. The climate change in 1989 that affected the circulation in the Strait of Georgia and behaviour of coho was associated with changes in other global climate indices which emphasise the impact that global climate events can have on the dynamics of regional salmon stocks.

Reviewers' Comments

Reviewer #1

The reviewer recommended that the paper be rejected. The reviewer noted that previous working papers containing survival forecasts for Strait of Georgia coho (S98-5, S97-6, and S96-11), which would have been a logical starting point for the authors were not referenced. The reviewer found the line of argument in the paper confusing and that there were several instances where important assertions were not supported by the data presented. The reviewer suggested that a consistent format for the presentation of data, correlations and statistical analyses would have increased the clarity of the paper and noted that many assertions lacked appropriate statistical tests. The reviewer noted that in some instances alternative explanations for observations had not been considered. The reviewer concluded by encouraging the authors to develop the climate based models and to compare their performance with accepted forecast models in a future submission to PSARC.

Reviewer #2

The reviewer found that although the conclusion that there is an association between salinity and catch distribution was adequately supported, this was not a new finding. Neither the originators nor the PSARC forecasts using the relationship were cited by the authors. The reviewer found that the authors' further explorations of the associations between climate and coho behaviour were interesting but that their conclusions were not convincing. The reviewer requested clarification of terminology and noted the absence of statistical tests to support many interpretative statements. The reviewer concluded by encouraging the authors to further develop their models but noted that in their current form they have not demonstrated any improvement to the established forecasting model based on spring salinities.

Subcommittee Discussion

The Subcommittee encouraged the authors to further develop their climate-based models of coho behaviour. The Subcommittee concurred with both reviewers in noting that the proposed model offered no improvement over the established forecasting model. The

Subcommittee also concurred with the reviewers that the authors had not adequately supported many of their hypotheses. For those reasons the Subcommittee could not accept the Working Paper.

S98-11 Rivers Inlet sockeye salmon: stock status update. D. Rutherford, C. Wood and S. McKinnell.

Working paper accepted subject to revisions

Working Paper Summary

This paper provides an update to PSARC S95-5 on the stock status of Rivers Inlet (Owikeno Lake) sockeye salmon. This report includes updated information on catch, escapement indices, total stock size indices, age composition, and juvenile abundance indices collected in 1995-1997. A recent dramatic drop in sockeye escapement was observed in 1994 and persisted for three years (Fig. 1). The 1995 and 1996 escapement estimates are the lowest on record at 73,000 and 65,000 sockeye respectively. The 1997 escapement of 285,000 was a considerable improvement over the 1994 to 1996 escapements and exceeded the target. However, this escapement was still slightly below the long-term median escapement of 312,000 sockeye.

Trawl surveys that were carried out from 1960 to 1969 were reinstated in 1995. The size and number of juvenile sockeye caught in standardised trawl surveys was used to develop an index of juvenile sockeye abundance. Indices of juvenile sockeye abundance have also been inferred for years where pre-smolt size is available but not trawl survey data. Juvenile abundance indices for brood years 1991 and 1994 were above the long-term mean suggesting that the freshwater production potential for Owikeno Lake had not declined from historic levels (Fig. 2). Furthermore, the 1991 brood year had above average juvenile abundance (as inferred from juvenile data) but returned poorly as adults in 1995 and 1996 indicating a very poor marine survival. Juvenile abundance indices for brood years 1995 and 1996 are below historic levels with 1996 among the lowest on record, which is consistent with the record low parent escapements.

In summary, the Owikeno Lake sockeye stock declined to record low levels in 1995 and 1996. All available data indicate that this decline resulted from poor marine survival, not a failure in freshwater production. Analysis of juvenile data also suggest that the overall decline in total stock since the 1970s cannot be attributed to a decline in freshwater production. Future returns to Rivers Inlet (Owikeno Lake) are expected to be low through to 2001 as a result of very poor escapements in 1994 to 1996. The median forecast of total returns in 1998 is 165,000 sockeye with a 25% probability that the return will be below 95,000 sockeye.

Rivers Inlet (Area 9) sockeye forecasts:

25%	50%	75%	80%	90%
276,000	165,000	95,000	83,000	63,000

The percentage refers to the probability that actual run size will exceed the specified forecast.

Reviewers' Comments

Reviewer #1

Reviewer #1 supported the authors' conclusions and recommended acceptance of the paper with minor revisions. Concern was expressed over the problem of assessing Owikeno Lake sockeye given the unreliable nature of the escapement data. The importance of the data obtained from reinstating the juvenile trawl surveys has been extremely valuable. The authors stated that it was difficult to fully endorse the authors' results given the suspect nature of the escapement data used in the analysis. It was recommended that the authors expand on the utility of the clear-stream escapement data and should consider adding a plot of the regression relationship between the SEDS escapement and the clear-stream index.

Reviewer #2

The reviewer reported the paper was interesting, well organised and well written. The strength of the paper was in the work done to index juvenile abundance and relating abundance to smolt size. The main concern was, much of the analyses embodied in the paper dealt with adult escapement data which by the authors' own admissions were "very unreliable estimates". The reviewer indicated that it was not possible, given the uncertainty in the data, to partition the cause of stock declines between freshwater or ocean influences. The authors were encouraged to continue their work of indexing juvenile sockeye abundance.

Subcommittee Discussion

The uncertainty in the escapement estimates is a major concern with the analyses and conclusions of the paper. The clear-stream index developed in recent years is an improvement, but extrapolations to total abundance are very uncertain. The Subcommittee concurs with the authors that the estimate of optimum escapement from the stock recruitment relationship is too uncertain (because of the escapement data) to endorse. The Subcommittee noted that the 200,000 escapement target presented in the report is a management target, and is not derived from technical assessments.

The Subcommittee discussed whether the juvenile abundance index was lower in recent years. The fact that the 1991 and 1994 juvenile indices exceeded the long-term average indicates that the potential for historical levels of smolt production continues to exist. The

1995 and 1996 brood year indices have declined reflecting reduced escapements. The relationship between escapement and subsequent juvenile indices for the four most recent years (1991, 1994, 1995 and 1996) is consistent with that observed in the 1960s. Only the inferred index for 1989 appears as a low outlier. The Subcommittee noted that additional information on hydroacoustic estimates of sockeye pre-smolt abundances referenced by one of the reviewers should be incorporated into the assessments. The authors mentioned that analysis of historical scale collections is currently underway to provide an alternative, 50-year time series of juvenile growth that indexes juvenile abundance.

The potential freshwater productive capacity does not appear to have changed given the high juvenile abundance indices in 1991 and 1994. The low returns in 1995 and 1996 are likely the result of poor marine survival. Returns are expected to remain poor through the year 2000 because of the poor brood year escapements in 1995 and 1996.

The Subcommittee noted that the current juvenile assessment program is sufficient to track juvenile abundance, but will not provide sufficient information to resolve questions of optimising production from the system. The juvenile assessment programs should be continued. The Subcommittee noted that technically feasible assessments programs could be conducted to provide accurate escapement estimates and to provide estimates of juvenile abundance.

Subcommittee Recommendations

The Subcommittee recommends acceptance of the 1998 Rivers Inlet sockeye forecasts of 165,000 (50% probability of a lower return), and 95,000 (25% chance of a lower return).

S98-12 A risk assessment for north coastal coho fisheries in 1998, with commentary on risk in southern inside and outside fisheries. B. Holtby and R. Kadowaki.

Working paper accepted subject to revisions

Working Paper Summary

The risk of further declines in abundance of the Babine Lake coho aggregate were examined using a stock-recruitment analysis of a 52 year time series reconstructed from an escapement to fixed date at the Babine River counting fence. Reconstructed total escapements and stock size have been declining at a constant rate since at least the early 1970s. Recruitment (total return) was forecast using the stock-recruitment relationship. Quasi time series forecasts based on reconstructed total stock size predict that escapements in 1998 will increase only marginally over the record low escapements observed in 1997, even in the absence of fishing mortality. Smolt outputs from Upper Skeena streams for 1997 were estimated using a population model applied to juvenile survey data collected in the fall of 1996 at sites throughout the area. Assuming forecast

marine survivals for Lachmach River coho, a coastal indicator stream, are applicable to the Upper Skeena, over 50% of streams will fail to reach 3 females/km even in the absence of fishing.

Similar analyses for Lower Skeena coho were based on the juvenile production model and measured smolt output at Lachmach River. With no fishing mortality there is an approximately 2% chance that Lachmach escapement would not reach estimated MSY levels, and that 24% of streams would reach escapements of a least 13 females/km. At current exploitation rates (50%-60%) nearly all lower Skeena streams would reach 3 females/km and about 50% would reach 13 females/km. Similar forecasts were made for 1997 that did not anticipate the large-scale recruitment failure. Consequently, forecasts for the Lower Skeena should be treated cautiously.

Standardised visual escapement counts pooled over Statistical Areas suggest that conservation concerns may be developing in Statistical Areas 5 and especially SA6.

Smolt production estimates for the west coast of Vancouver Island based on the juvenile production model indicate that an exploitation rate of less than 50% would be required to ensure that escapement to all surveyed streams would reach at least 1 female/km. At exploitation rates of 30% approximately 50% of streams would achieve escapements of 9 females/km. The marine survival forecast for Robertson Creek Hatchery was used.

Observed smolt counts were available for Black Creek. Marine survival forecasts for Quinsam River Hatchery were used. With no fishing mortality there is an approximately 18% chance that escapements to Black Creek would fall below 9 females/km (total escapement of 500), but there is less than a 20% chance of achieving MSY escapements (1500-2000). Smolt production estimates derived from the juvenile production model were also available for streams around the Strait of Georgia and in the Lower Fraser. With no fishing mortality, escapement to about 7% of streams will not reach 1 female/km, while escapement to about 32% of surveyed streams will not reach 3 females/km. At 1997 exploitation levels (15%-35%) escapement to between 8% and 15% of streams would not reach 1 female/km.

Reviewers' Comments

Reviewer #1

The reviewer felt that the authors perhaps tackled too much in one paper, which limited the in-depth treatment of any one area, or approach. It was suggested the authors focus their assessments by region, preferably in separate papers and in conjunction with the authors of other working papers for these regions. He also suggested that the authors have understated the risks as they have not been able to include the added risks of data and management uncertainty, and demographic and genetic risks in their scenarios. The reviewer also recommended the authors define risk in their context, for example what is a limit reference point and how were they determined. A list of additional specific points was included for consideration.

Reviewer #2

This reviewer had difficulty in understanding the risk analysis methods employed, and did not understand the process of reaching the conclusions in the paper. The reviewer was surprised not to see an analysis of ocean survival rates using CWT analysis. A comparison of freshwater productivity, ocean survival and exploitation rate by region was also suggested. Despite reservations concerning the methods, the reviewer believes the conclusions of the paper are true.

Subcommittee Discussion

The Subcommittee recommends acceptance of this paper subject to revisions.

The Subcommittee notes that this paper builds on previous advice given by PSARC in the fall of 1997 (PSARC Working Paper S97-12). A high level of concern was expressed at that time for Upper Skeena coho stocks (principally the Bear-Sustut, Babine and Bulkley-Morice) based on low abundance estimates of adults and juveniles in these areas. In this paper, adult female spawner density escaping above the Babine River fence has dropped from almost 25 females per km in the 1960s to an average of a little over 3 females per km (range 1.4-8.1) in the 1990-96 period to a record low of 0.3 females per km in 1997. This paper identifies values from 10 to 30 females per km as being the desirable range to maximize habitat use, maximize yield and preserve ecosystem function. For the Babine stock, values above 10 females per km have not been seen since the late 1970s.

The decline in the Babine Lake coho aggregate appears to have been primarily the result of over-fishing, exacerbated by a severe decline in marine survival in 1997. Recovery is unlikely, even in the absence of fishing, unless survival improves.

The Subcommittee expressed concern with the reliability of the escapement estimates being used to consider status of coho stocks in Areas 5 and 6. Surveys in Area 5 have become more infrequent in recent years and have been most often targeted on sockeye enumeration. While the Subcommittee notes that the coho counts in these areas matches known decreasing escapement trends in adjacent areas, there is further work that should be done prior to making definitive statements on the status of these stocks. Past escapement records for streams in these areas should be carefully reviewed.

The Subcommittee notes the significant level of enhancement activity that has taken place in recent years in some Skeena tributaries (Babine and Bulkley) and that the impact of such activity has not been fully assessed.

The Subcommittee requested the authors to distill the risk assessment data into a series of summary tables.

Table 1. Summary of escapement risk plots for the **Upper and Lower Skeena** aggregates. The table entries are the proportions of surveyed streams that will not reach the indicated escapement levels with no fishing mortality. The percentiles of smolt survival are those for the Lachmach forecast (see S97-12) and are the probability that survival will be worse than the bracketed level. The survival observed in 1997 was approximately the 5th percentile of the 1997 forecast.

		percentile of smolt survival forecast			
aggregate	females/km	50% (0.091)	25% (0.076)	10% (0.064)	5% (0.056)
Upper Skeena	1	0.40	0.40	0.40	0.40
	3	0.52	0.56	0.56	0.67
	9	0.80	0.88	0.88	0.88
	13	0.88	0.88	0.96	0.96
Lower Skeena	1	0	0	0	0
	3	0	0	0	0
	9	0.05	0.05	0.25	0.30
	13	0.25	0.29	0.45	0.45

Table 2. Summary of escapement risk plots for the **west coast Vancouver Island** aggregate. The table entries are the proportions of surveyed streams that will not reach the indicated escapement levels with no fishing mortality. The percentiles of smolt survival are those for the Robertson Creek forecast (see S98-5) and are the probability that survival will be worse than the bracketed level.

		percentile of smolt survival forecast			
aggregate	females/km	75% (0.069)	50% (0.030)	25% (0.013)	10% (0.006)
WCVI	1	0	0	0.04	0.23
	3	0	0.03	0.25	0.65
	9	0.13	0.37	0.80	1.0
	13	0.23	0.52	0.96	1.0

Table 3. Summary of escapement risk plots for the **Strait of Georgia and Lower Fraser** aggregate. The table entries are the proportions of surveyed streams that will not reach the indicated escapement levels with no fishing mortality. The percentiles of smolt survival are those for the Quinsam River forecast (see S98-5) and are the probability that survival will be worse than the bracketed level.

		percentile of smolt survival forecast			
aggregate	females/km	75% (0.018)	50% (0.012)	25% (0.008)	10% (0.005)
Strait of Georgia	1	0.06	0.06	0.13	0.22
	3	0.20	0.33	0.53	0.72
	9	0.66	0.89	0.97	0.98
	13	0.86	0.95	0.97	1.0

Subcommittee Recommendations

The Subcommittee recommends an extremely cautious approach to management of fisheries harvesting Upper Skeena coho stocks in 1998. For Upper Skeena coho, if marine survival does not improve, populations will likely continue to decline, even in the absence of fishing mortality. Risk of extinction increases exponentially with declining population sizes. The Subcommittee is also very concerned about the status of Strait of Georgia/Lower Fraser coho stocks. Although not in as perilous a state as Upper Skeena coho, Strait of Georgia/Lower Fraser coho also have to be managed with caution. Even with no fishing mortality, most streams will likely be underescaped. Coho stocks on the west coast of Vancouver Island appear to be somewhat better off, but a cautious approach is nevertheless required.

S98-13 Stock assessment of Thompson River/Upper Fraser River coho salmon. J. Irvine, K. Wilson, B. Rosenberger and R. Cook.

Working paper accepted subject to revisions

Working Paper Summary

The purpose of this working paper was to provide an assessment of the status of coho salmon from the Thompson River/Upper Fraser River. The paper was a first attempt at providing advice specific to Thompson and Upper Fraser coho. Much of the assessment relied upon the analysis of spawning escapement data.

Escapements to unenhanced streams in the South Thompson were at moderate levels from 1975 through 1983. For the next six years, returns were relatively high, and since then there has been a definite decline (Fig. 3). As well, the proportion of South Thompson streams inspected with no spawning coho seen (Fig. 4) generally increased during the time series, also indicative of poor recent returns. Escapements to two enhanced South Thompson rivers (Eagle and Salmon) followed a similar pattern to unenhanced streams although the rate of decline in the last 9 years was steeper. Returns to unenhanced North Thompson streams (Fig. 5) followed a similar temporal pattern as returns to the South Thompson did, except the magnitude of temporal variations was less. A period of modest returns from the mid-1970s to 1983 preceded about 5 years of relatively good returns. Since 1989, returns have been relatively poor. Escapement data for the Lower Thompson/Upper Fraser were of shorter duration and greater uncertainty than for the North and South Thompson. Escapements in the four most recent years were generally lower than in previous years. A recent preponderance of males in the spawning escapements of some Thompson streams, a suggestion that there may be some declines in sizes of fish at return, and what appeared to be a tendency for females returning to be less fecund than they used to be, are also causes for concern. Each of these factors reduces the reproductive potential of the population.

An analysis of CWT data did not show any appreciable differences in the marine tag recovery patterns among South Thompson, North Thompson, and Lower Thompson/

Upper Fraser stocks. Although some minor differences in the marine recovery patterns of Thompson and Lower Fraser coho were seen, opportunities to separate harvests of these two stock groups appear to be rare. Possible exceptions are late September-October fisheries in Georgia Strait North and coho fisheries within the Fraser River after the end of October.

Fishery managers need to be aware of potential impacts of fisheries in Puget Sound (Washington) on Thompson coho.

The authors warn that selective mark fisheries, unmonitored fisheries, and incidental mortality will compromise our ability to evaluate the success of measures to conserve Thompson River/Upper Fraser coho.

Reviewers' Comments

Reviewer #1

Reviewer #1 found the working paper to be a useful compilation of the limited amount of information available on North, South, and Lower Thompson coho escapement, enhancement history, biology, and exploitation/survival. However, he considered that the focus on the last decade severely limited direct inferences that could be made about the overall status of these stocks from an historical perspective. Although he agreed that the authors' conclusions about recent declines in escapement were reasonable, he did not agree that the stocks had "declined significantly over the last 20 years". He suggested revisions to include a statistical analysis of the trends in all stocks, and a graph of the "zero" coho escapements for the North and Lower Thompson stocks.

This reviewer was concerned that future stock assessment capability for Thompson coho would be hampered by selective mark fisheries, a problem flagged by PSARC several years ago, and one that he felt could seriously compromise DFO's and CDA's attempts to elicit stakeholder support for large reductions in exploitation rate. Because of this, he endorsed the development of DNA sampling or alternative CWT measures to offset the problems raised by mass marking and selective mark fisheries. He also considered the present analysis of CWT catch distribution to be weak because of limited data, and suggested that an attempt be made to determine run timing using CPUE data. He pointed out an apparent discrepancy in run timing inferred from DNA stock composition data and CPUE data.

Finally, this reviewer considered that it was inappropriate to speculate about the existence, form, substance, or implications of a CDA/US fishing arrangement for 1998. He recommended, instead, that the authors simply flag the issue by stating the overall measured exploitation rate in 1997 and the proportion of the total exploitation accounted for by Washington net and sport fisheries, noting that exploitation by in-river Fraser fisheries was not measured.

Reviewer #2

This reviewer considered that the authors had made progress in the difficult task of assessing the status of Thompson River coho by collating and reviewing data that varied in accuracy and precision, and presenting their results in a form that should be useful to fishery managers. He pointed out a number of statements that needed to be clarified or made more specific. He considered that estimates of exploitation for 1997 might be very misleading without the inclusion of incidental fishing mortality. He also objected to imprecise statements about the "increase in harvest of Thompson and Lower Fraser coho in Washington State" in 1997, and the "relatively high exploitation of Fraser/Thompson coho in Washington fisheries". Finally, he thought that there was insufficient discussion of research and monitoring needs given the obvious limitations of data.

Subcommittee Discussion

The Subcommittee discussed how "zero escapement counts" should be presented and concluded that it was most appropriate to use the term "none observed" in cases where streams had been inspected but no coho had been seen. These observations are informative as an index, but do not imply that coho escapements were actually zero. Following up on the first reviewer's concerns, the Subcommittee asked the authors to express escapement trends with respect to specific time periods, to examine these trends quantitatively, and to provide additional information on the proportion of streams with "none observed" for the North Thompson stock.

The Subcommittee recognised the desirability of identifying how the run timing of Thompson/Upper Fraser coho might differ from other more productive coho stocks, and discussed whether there was any opportunity to infer run timing from the data available. The Subcommittee emphasized that, by themselves, the stock composition proportions based on CWT analyses and DNA analyses provide no insight about run timing. The Subcommittee also considered that the average run timing curve based on CPUE data might be very misleading if fishing effort changed substantially over the time period in question, because catch was unlikely to increase linearly with effort over a wide range in effort.

The Subcommittee discussed the reliability of the exploitation rate analyses, and agreed with the second reviewer that total fishing mortality may have been underestimated significantly in 1997 because there were likely sources of fishing mortality that had not been accounted for (e.g., incidental mortality and illegal retention). Given these reasonable concerns that fishing mortality may have been underestimated in Canadian fisheries, the Subcommittee agreed with reviewers that the authors should state, but not overemphasise the proportion of the total exploitation accounted for by Washington net and sport fisheries, and avoid speculating about the implications of possible CDA/US fishing arrangements in 1998. The Subcommittee asked the authors to include the number of tag recoveries in Table 6.1 to help determine whether the discrepancy in estimated exploitation rate between Lemieux and Louis Creeks was real or simply an artifact of low sample sizes.

The Subcommittee recommended that an updated assessment of Thompson River/Upper Fraser coho be prepared for review at a subsequent meeting. The updated document should include consideration of additional data on spawning escapements prior to 1975, CWT data for other relevant stocks, implications of incidental and in-river fishing mortality, and differences in fecundity and freshwater survival that affect the relative freshwater productivity of Thompson versus coastal coho stocks.

The Subcommittee concluded that total returns and spawning escapements of coho in the North and South Thompson Rivers have declined to record low levels over the last ten years. An assessment of the implications of these poor spawning escapements given recent low levels of marine survival (<2%) is presented in another working paper (S98-18).

Subcommittee Recommendations

The Subcommittee recommends that programs be initiated to offset the loss of CWT assessment information associated with new selective mark fisheries (see General Subcommittee Discussion and Concerns). Selective mark and unmonitored sport fisheries may seriously compromise DFO's ability to evaluate the success of measures to reduce fishing mortality on Thompson River/Upper Fraser coho.

S98-14 The use of trawl surveys to estimate prefishery juvenile abundance of coho salmon. R.J. Beamish, D. McCaughran, R. Sweeting and M. Folkes.

**Working paper not accepted **

Working Paper Summary

A rope trawl fished at approximately 5 knots was used to establish indices of juvenile coho abundance in the Strait of Georgia. The actual abundances were not determined, but are believed to be higher than the indexed values. The estimates of 3.6 million in September of 1996 and 2.8 million in September of 1997 indicated that the total returns in 1998 could be less than in 1997. The indexed abundances are minimal estimates as the catchability of the net is probably lower than used in this analysis. The minimal estimate of 3.6 million in 1996 compares with an estimated total return of about one million in 1997 and indicates that the amount of fall/winter marine mortality is an important component of the total marine mortality that determines the final carrying capacity for the brood year.

Reviewers' Comments

Reviewer #1

The reviewer indicated the methodology applied successfully tracks the migration of juvenile coho salmon out of the Strait of Georgia, and has the potential to provide relative indices of juvenile abundance and stock composition. The reviewer was concerned that

the authors failed to explain the details of some of the methods applied. Statistical procedures were recommended to better estimate the uncertainty in the data. The reviewer agreed that "These initial surveys provide an excellent base upon which to design future investigations". However, the reviewer suggested concentrating on refining the methodology rather than focusing on some dubious abundance estimates. A series of additional specific concerns were outlined in the paper. The reviewer indicated that the estimates of total juvenile abundance are too uncertain at this stage for further discussion of the implications of this preliminary data.

Reviewer #2

This reviewer indicated major revisions were required to clarify the trawl survey design and sampling methods, which are currently inadequately described. Also, the paper required more statistical rigour. Specifically, the authors need to conduct appropriate statistical tests to support important statements and conclusions present in the paper. Some of the differences discussed in the text between the September 1996 and 1997 surveys could be caused by a "vessel effect", since a commercial fishing vessel made most of the tows in September 1997 while the DFO Research Vessel, W.E. Ricker, made all the tows in 1996. With only two net calibration measurements on the commercial vessel, the reviewer was not convinced that the possibility of a "vessel effect" had been adequately evaluated. This is an important point because the authors concluded that the size of the returning run from the 1997 brood year could be less than the 1996 brood year, even though the difference between the September 1996 and 1997 coho estimates was not that great, and therefore would be sensitive to a potential sampling bias caused by using different vessels in the two surveys. The speculative parts of the discussion on condition factor and fall/winter mortality should be removed until supporting evidence is obtained. It was not clear why this paper was submitted to the PSARC Salmon Subcommittee at this time. Several more years of data and more critical statistical testing are required before the potential usefulness of this survey for salmon stock assessment can be evaluated.

Subcommittee Discussion

The Subcommittee discussed the lack of a detailed description of the trawl survey design in this paper. It was noted that there were no references to previous work related to trawl surveys of which there are numerous studies in the literature. Although there have been no swept volume estimates conducted on juvenile salmon previously, there are numerous reports for invertebrates, groundfish and other marine animals using this technique. Concern was expressed about the variation in sampling procedures between years, where vessels and gear were changed, which in the view of the Subcommittee could be an explanation for any variation in the results of this study. Given these concerns it was agreed that there was a need for a more detailed description of the sampling design.

With respect to the abundance estimates the Subcommittee was again concerned that the lack of a description of the sampling design does not allow for the proper evaluation of the point estimates and confidence intervals provided in this paper. It was suggested that

more rigorous statistical analyses are required.

Subcommittee Recommendations

The Subcommittee recommends that the paper not be accepted as it currently stands. The Subcommittee could not accept the conclusions in this paper based primarily on the lack of a proper description of the survey sampling design. It was suggested that major revisions be done with emphasis on the survey sampling design and a more detailed description of the methodology after which it should be resubmitted and reviewed by a statistician.

S98-15 Stock status of Cowichan chinook salmon. D.A. Nagtegaal and B. Riddell.

Working paper accepted subject to revisions

Working Paper Summary

Considerable interest has been focussed toward the chinook stocks in the southern portion of the Strait of Georgia due to the perceived decline in these stocks and their importance to local fisheries. In 1985, a chinook rebuilding plan was initiated through the Pacific Salmon Treaty between the United Sates and Canada to stop the decline in escapements to naturally spawning chinook stocks and attain escapement goals in selected indicator stocks (Cowichan, Nanaimo, Squamish) by 1998. This report compiles the information available on the status of the Cowichan chinook stock, including escapement data, habitat assessment, biological data, juvenile production, ocean catch distribution, enhancement history, trends in survival and exploitation rates.

Chinook escapement to the Cowichan River had declined during the mid-1980s but have generally been increasing since 1990. Natural spawners to the system are primarily comprised of 3 and 4 year old fish. Hatchery chinook production began in 1979 and a significant expansion of the facility in 1992 increased production from less than 500,000 chinook juveniles to more than 2.5 million. Enhanced contribution to the stock, measured in terms of coded-wire tag expansion information, indicated that this contribution has increased to approximately 40% of the total return in 1997. Several factors affecting the number and distribution of natural spawners to the system were discussed including ocean fishery dynamics, in-river water flow, distribution of spawning chum salmon, native food fishery and hatchery broodstock removals, and seal predation. Exploitation rates have declined for the 1991 and 1992 brood years (the most recent complete broods) and are likely a reflection of the management implemented reduction in sport fishing effort in Georgia Strait.

The decline in escapement has been stopped and for 1995 and 1996 chinook returns to the Cowichan River have been above the original escapement goal of 12,500. It is necessary to continue monitoring this system to further evaluate the biological basis for this escapement goal. It is recommended that the Cowichan system remain a key

escapement indicator stock. It is also recommended that the impact of enhancement on the natural chinook population be assessed and a review of enhancement procedures and outcomes be initiated. It would be desirable to further assess the impact of chum spawning on the reproductive success of chinook, and continue to monitor the impact of seal predation in the estuary.

Reviewers' Comments

Reviewer #1

The first reviewer commented that the working paper provided the assessment data in a summary format, often graphically or using multiple year means. While this made simple and easy reading, it was difficult to conduct a useful evaluation of the data used to make the conclusions. It was noted that although the author concluded the Cowichan chinook stock is in a rebuilding mode it was not evident that the assessment was actually based on the Chinook Technical Committee (CTC) criteria. In fact when the reviewer applied some of the CTC criteria a status of "not rebuilding" or "indeterminate" was determined. Of particular concern was the inclusion of the hatchery contribution to the status assessment of the stock. With about 50% of the escapement of first generation hatchery origin, it is not clear whether the CTC criteria to assess naturally spawning stocks are applicable.

Reviewer #2

The second reviewer noted that the working paper provided a good account of Cowichan chinook stock including a description of the life history and the freshwater and estuarial habitat of the fish. This description and possible influences on the production and survivals is important for understanding what has influenced Cowichan production. The reviewer noted that the data presentation was confusing and that the working paper would benefit from editing and reorganising. The lack of confidence limits for any of the estimates of abundance was noted. If the calculation of confidence limits is not feasible, then some discussion on the reliability should be included. For instance, the reliability of the fence operation and its counts and the estimates derived from carcass tagging.

Subcommittee Discussion

The working paper was accepted noting Subcommittee requirements for additional analysis required to identify the enhanced component and its results on rebuilding. The Subcommittee was informed that of the Lower Georgia Strait Chinook Stock Group (LGS) which is composed of 17 rivers with the Cowichan, Nanaimo, and Squamish Rivers the main producers, the Cowichan stock is now the only stock that has an adequate assessment program. The Subcommittee, while acknowledging that the objective is to rebuild wild stocks and that the use of enhancement was established as part of the policy to assist rebuilding, notes that the stock now has about a 50% enhancement supplement. Strait of Georgia chinook stocks are all enhanced to some degree and there are outstanding policy questions regarding whether these stocks should be returned to wild

status as they rebuild.

Under low water conditions, chinook tend to spawn in the mid to lower reaches of the river. These are the same areas in which chum salmon spawn later in the season. This second utilisation of the same area, may impact the chinook spawn deposition. The working paper also noted an increasing seal population in Cowichan Bay and referenced previous studies done in 1988 which estimated that salmon formed a significant part of the seal diet.

The Subcommittee concluded that this working paper does not change the previous advice provide on the LGS stocks (PSARC Working Paper S96-17). It is apparent that continued efforts to rebuild this stock and the LGS group as a whole and meet escapement goals, will require continued harvest controls. A policy decision will be required regarding the amount and continuation of enhanced contribution to the stock as rebuilding progresses.

The Cowichan River chinook stock is an important producer and serves as the main index stock representing a stock aggregate of seventeen populations. The Subcommittee supports the current monitoring and assessment activities. Further assessment would be desirable to determine the impact of chum spawning on the reproductive success of chinook salmon. The Subcommittee notes the potential impact of seal predation on chinook salmon in the estuary.

Subcommittee Recommendations

The Subcommittee recommends that the enhancement impact on wild populations in the LGS complex be assessed relative to the results in the Cowichan system. This would include the identification of the level of enhancement component, its effect on rebuilding and the utilisation of brood stock for the various sea pen operations and release strategies.

S98-16 Intra-annual changes in the abundance of coho, chinook and chum in Puget Sound in 1997. R.J. Beamish, M. Folkes, R. Sweeting and C. Mahnken.

**Working paper not accepted **

Working Paper Summary

In 1997, the authors carried out joint US-Canada studies in Puget Sound on juvenile Pacific salmon. The rope trawl fished from the W.E. Ricker was an effective method of sampling salmon as indicated by the size of the catches and the size of the fish in the catch. Ocean age 0 coho were first abundant in July but not in September. Ocean age 1 coho were rarely caught. Ocean age 0 chum salmon were the most abundant of all Pacific salmon. Surprisingly, the abundance estimates of juvenile chum salmon increased dramatically over the same period that juvenile coho abundance declined

dramatically.

It is proposed that the movement of coho out of Puget Sound is related to the abundance of chum as the dominant items in the diet of both species is similar and the movement of coho out of Puget sound corresponded with the movement of large numbers of juvenile chum into the feeding areas of coho. However, coho movement is not a direct result of food depletion as the large abundances of chum and chinook continue to feed and maintain condition factors through to September. The large abundances of chum and chinook, in September relative to returns, indicates that final brood year size is determined later in the year and not in the early marine period. It is probable that coho brood year strength is determined by similar mechanisms.

Reviewers' Comments

Reviewer #1

Reviewer #1 was not convinced that this paper was appropriate for PSARC as it is dealing with abundance of US stocks in Puget Sound. It was suggested that this paper be combined with the papers dealing with the Strait of Georgia, Juan de Fuca and WCVI into one paper.

The reviewer pointed out that estimates of precision of the data were commented on but not provided, as they were so large. This prevented the reviewer from supporting the conclusion that apparent population differences between the two times are significant. It is not possible to support the main findings without additional substantiating evidence.

Concern was expressed regarding the catchability of the sampling gear with respect to the size of the fish and the lack of precision estimates around the means.

Reviewer #2

This reviewer also pointed out that there was not enough information in this paper to substantiate the inferences made by the authors. A time series of survey data would allow for a proper evaluation of the indices.

Problems with the stratification scheme for the survey were raised and it was pointed out that confidence intervals for the abundance estimates were not presented.

This reviewer raised several questions about the survey design and methodologies. As a result the reviewer could not support the authors statements although they are interesting.

Subcommittee Discussion

The Subcommittee had a very brief discussion on the data presented and methods used in this paper. Similar to S98-14 the sampling design was not described in detail which

restricted the ability to determine whether the analysis of the data was appropriate. It was agreed that the data as provided were insufficient to support the conclusions made, however it was noted that the hypothesis was worthy of additional consideration and research. Following major revisions relating to a detailed description of the survey sampling design and additional statistical analysis including statement of uncertainty this paper could be resubmitted for review.

Subcommittee Recommendations

The Subcommittee did not accept this paper. Following major revisions relating to a detailed description of the survey sampling design and additional statistical analysis including statement of uncertainty, this paper could be resubmitted for review.

S98-17 Dynamic change in proportion of hatchery-reared, wild ocean and stream type chinook in their first and second years in the Strait of Georgia. Z. Zhang, R.J. Beamish and B.E. Riddell.

Working paper accepted subject to revisions

Working Paper Summary

Otolith microstructure was used to identify hatchery-reared and wild-ocean and stream-type chinook in their first and second ocean year in the Strait of Georgia. Samples used for the analysis were collected in the early summer, late summer and late fall in 1995, 1996 and 1997. The percentage of wild fish dropped from 59.2% in late summer to 36.8% in the late fall of 1995, and more dramatically from 60.4% in the late summer to 19.2% in the late fall of 1996. The decrease in the percentage of wild chinook in 1996/1997 may have resulted from a higher mortality in the late fall and may indicate that wild chinook may be in low abundance in the 1998 and 1999 fishery. There also was a general decrease in lengths from the 1995/1996 samples to the 1996/1997 samples, suggesting that ocean conditions were less favourable for growth in 1996/1997.

It is difficult to understand all of the results as migration behaviour, sample sizes and a general poor understanding of the marine phase of the life history of chinook complicates any interpretation. However, the change in 1996/1997 to a relatively high percentage of hatchery-reared fish is noteworthy. These authors also suggest that it is time to improve our understanding of the dynamics of the various stocks, life history and rearing types that make up the Strait of Georgia chinook fishery.

Reviewers' Comments

Reviewer #1

Reviewer #1 found that the authors clearly stated the purpose of the paper to determine the proportion of hatchery-reared juvenile chinook in the Strait of Georgia. In answering this question the reviewer felt there were two major problems the authors needed to

address. The first problem being that the Strait of Georgia is not a closed system hence juveniles are able to easily migrate in and out of the sample area. Second and more importantly the paper lacks a presentation of the sampling design.

The reviewer suggested a fuller discussion of the error in classifying a fish as wild or hatchery. He felt that the identified 11% reading error is a minimum.

In conclusion this reviewer did not think the paper supplied enough information to judge the implications made by the authors that there has been large shifts between hatchery and wild proportions from September to November.

Reviewer #2

Reviewer #2 described the authors interpretations as being plausible and as good hypotheses, however in his judgement the analyses presented were not sufficiently convincing to be endorsed by PSARC.

This reviewer did not feel that the information provided was sufficient to justify the suggestion made by the authors that the fishery in 1998 and 1999 in the Strait of Georgia be closely monitored for hatchery-reared and wild percentages. One problem he identified was that it seems to be based only on the relative and not absolute abundances. There is no way of determining whether the change in percentages is due to the increase or decrease in the abundance of wild or hatchery juveniles.

The reviewer was concerned about whether the composition of the catches were representative of the Strait of Georgia as a whole. He suggested the authors need to demonstrate that their sampling design is adequate to support the analysis and inferences they make from the catch samples. In addition the authors need to justify their assumptions about relative catchablilty.

In conclusion, this reviewer felt that the purpose of the paper was not clearly stated as it did not generate advice relevant to fishery management. The data and methods were considered to be inadequate to draw the identified conclusions largely because the data and methods were not described in sufficient detail. The reviewer did not consider the recommendations to be useful for fishery managers. He suggested that the authors attempt to develop a method of estimating absolute abundance in their surveys.

Subcommittee Discussion

The Subcommittee discussed the relevance of the data presented in this paper. It was pointed out that without a longer time series of data it is not possible to determine whether the percentage of hatchery chinook in the Strait of Georgia found in this study is any different than normal or a reason for concern. As a result the Subcommittee could not agree with the authors conclusion that in 1997 the hatchery percentage was significantly different than normal and secondly, that the harvest of chinook in 1998 be closely monitored. It was not clear to the Subcommittee what sampling the fishery in 1998 would

provide in the form of management advice.

Subcommittee Recommendations

The Subcommittee recommends that this paper be accepted subject to revisions relating to additional statistical work and the inclusion of some statement of uncertainty.

S98-18 A risk assessment for Thompson River coho salmon. M. Bradford.
Working paper accepted subject to revisions

Working Paper Summary

Coho salmon populations of the Thompson River drainage have been declining at a rate of 50-70% per generation since 1988. Of a sample of 34 extant populations in 1988, no fish were observed in 11 of them (32%) in 1997. To identify the causes of these declines, freshwater production was modelled using reconstructed smolt abundances. The results of this analysis showed that: (1) interior populations are likely less productive than coastal populations, (2) Thompson coho populations are currently in the linear portions of their smolt-spawner relations, and (3) populations are well below levels required to fully seed freshwater habitats. Simulations showed that the declines in Thompson coho are due to a roughly equal effect of declining marine survivals and fishing at inappropriately high rates in recent years. Under current ocean conditions Thompson coho will continue to decline in the absence of fishing and the rate of decline will increase with fishing. Because of the current poor population status, and because the risk of extinction increases exponentially with decreasing population size, it is recommended that no fishing mortality be imposed on these population.

Reviewers' Comments

Reviewer #1

The reviewer indicates the paper was a well written, well structured assessment of Thompson coho. The data are evaluated in a new and refreshing way, the results are presented in a concise and readable format, and the recommendations and conclusions are derived logically from the presented data, analyses and discussion. The author notes that this paper is not a full risk assessment for this stock group, however, given the incontrovertible evidence of extremely low and declining spawner abundance in conjunction with the author's conclusion that *"...risk increases **exponentially** with decreasing population size"* should provide managers with a clear and succinct view of the level of risk currently faced by Thompson River coho. Escapements are now low and, regardless of the completeness of the quantification of risk, it seems unlikely that more detailed future risk assessments can reach any conclusion other than that the risk of loss of this stock group is now extreme. On that basis alone, the conclusions and recommendations of this paper should be accepted by the Subcommittee.

The reviewer identified three areas where the paper should be improved: the "broken stick" model needs to be described more thoroughly; model performance should be evaluated against other models, and outputs such as *K* (smolt carrying capacity) should be verified against existing data; alternate sources of input data specific to the Thompson System are available and should be used. The reviewer recommends that the Subcommittee accept the paper subject to reanalyses using system-specific estimates of *MS* (marine survival) and *h* (exploitation rate).

Reviewer #2

This paper is concise and clearly articulated and demonstrates that Thompson River coho are at risk. Long-term trends in escapement to levels less than 500 animals in some population/management units in themselves provides irrefutable evidence that risk of extinction is real. The advance made in this particular paper is the attempt to quantify and distinguish between effects of ocean survival and exploitation rates on population growth rates. The use of Lande's (1993[3]) equation for estimating time to extinction reinforces the important conclusion that risk increases exponentially as populations decline. Unfortunately, there is a lack of Thompson coho assessment data that on its own does not allow an independent assessment of risk. More detail on the broken-stick model is needed if indeed the only reference is Bradford and Myers (unpublished data). The reviewer suggests that the carrying capacity *K* is poorly determined by the data. The sensitivity analysis of the effect of α on population trajectory given ocean survival and harvest rate reveals uncertainty in α is important. The uncertainty in *K* is particularly important if it is going to be linked with a threshold escapement N* upon which effects of future harvest policy will depend.

Reviewer #3

The third reviewer felt this was an excellent analysis that has serious implications for Thompson River coho. The approach is innovative and provides a powerful mechanism for performing the analysis of consequences of alternative fishing mortality rates and ocean survivals. As the analysis depends largely on the estimates of fishing mortality rates and ocean survivals it would be useful to have a fuller presentation of the data from a number of CWT data sets.

Subcommittee Discussion

The Subcommittee agreed that this paper is a good step towards a comprehensive risk analysis framework for Thompson River coho and accepted the working paper following minor revisions. In agreement with all three reviewers, the Subcommittee was concerned that the CWT data from non-Thompson coho stocks used to estimate surrogate exploitation rates and ocean survival rates for Thompson coho may not be representative. It was noted that time series of ocean survival and exploitation rates exist for some Thompson River stocks. The author has agreed to consider the use of these data in

[3] Lande, R. 1993. Risks of population extinction from demographic and environmental stochasticity and random catastrophes. American Naturalist 142: 911-927.

revisions of the paper.

The Subcommittee also agreed with reviewers' comments that more detailed description of the "broken-stick" model be included in revisions to the paper. It was noted that alternative recruitment functions to describe the relationship between spawners and smolts are possible. The Beverton-Holt model assumes higher productivity at low stock sizes compared with the broken-stick model. The author has agreed to include results using the Beverton-Holt model in the final version of the paper. Considerable discussion focused on how the uncertainty in the productivity parameter α (mean smolts/females at low stock size) and ocean survival rates could affect rates of population growth *r*. The Subcommittee concluded that the author should develop reasonable bounds on these parameters and expand upon the effects of uncertainty on population trajectories under various scenarios of exploitation. A useful analysis to pursue is a re-analysis of the South Thompson data that does not remove the effects of the hatchery production as was done in the paper.

The Subcommittee was concerned about whether the effects of fishing were overstated (or understated). The author stated that estimates of exploitation rates from CWT data tends to underestimate actual fishing mortality, therefore, the recovery of stocks under a no-fishing policy might be faster than otherwise anticipated. The Subcommittee noted that the paper does not identify biological reference points or specific conservation limits for Thompson River coho and noted that there is a need for research to identify these limits in keeping with the Precautionary Approach concept.

While there is little evidence that the 10+ years of steady stock decline is related to freshwater habitat effects, the Subcommittee recognised that a thorough analysis of freshwater effects on productivity has not been done.

The Subcommittee concurs with the author's conclusion that Thompson River coho salmon have declined since 1988 at rates of 40-70% per generation, and the Eagle and Salmon populations are currently 1-2% of the 1988 escapement levels. Many streams have declined to "none observed" status in 3 generations. The Subcommittee agrees that the cause of the decline of Thompson coho populations since 1988 appears to be a combination of declining marine survival and recruitment overfishing. If marine survival does not improve, Thompson coho salmon will continue to decline even in the absence of fishing. Fishing mortality will increase the rates of decline in these populations and will increase the risks of extinction. The Subcommittee also noted that since the risk of extinction increases exponentially with decreasing population size the need for corrective action is increasingly urgent.

The Subcommittee further notes that, as a result of very small brood year escapements, the risks and conservation concerns for Thompson coho will be even higher in 1999 and 2000, unless there is a reversal in ocean conditions.

Subcommittee Recommendations

The Subcommittee recommends a very cautious management approach in 1998. Given the forecast of low marine survival, even in the absence of fishing, Thompson coho will continue to decline further from the already low escapement levels.

4. Figures

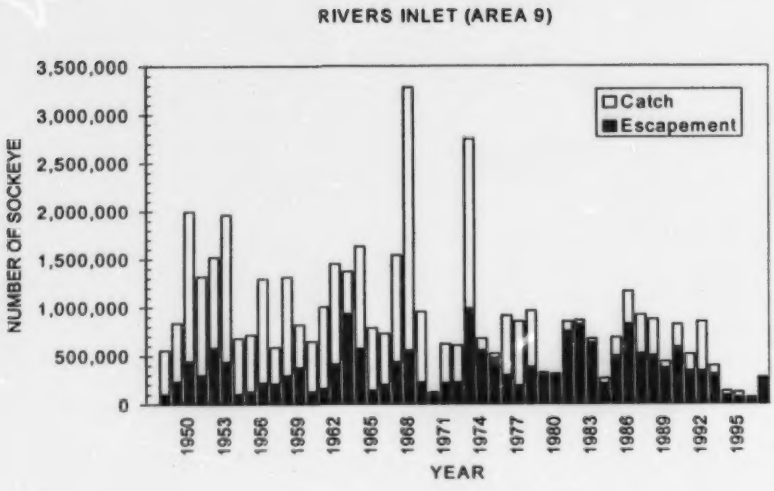


Fig. 1 Catch, escapement and total stock size for Area 9 sockeye, 1948-1997.

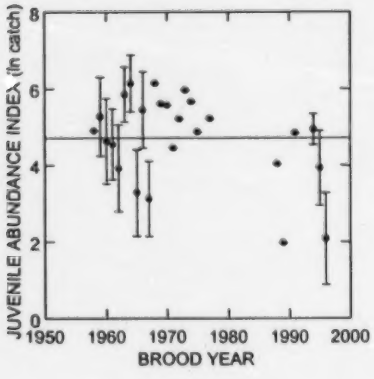


Fig. 2. Variation in juvenile abundance index by brood year. Average index indicated by horizontal line. Circles with error bars indicate index measured directly, circles only indicate index inferred from pre-smolt size.

Fig. 3 Aggregate Coho Escapement to 19 Streams in the South Thompson (trendline is a 3yr moving average)

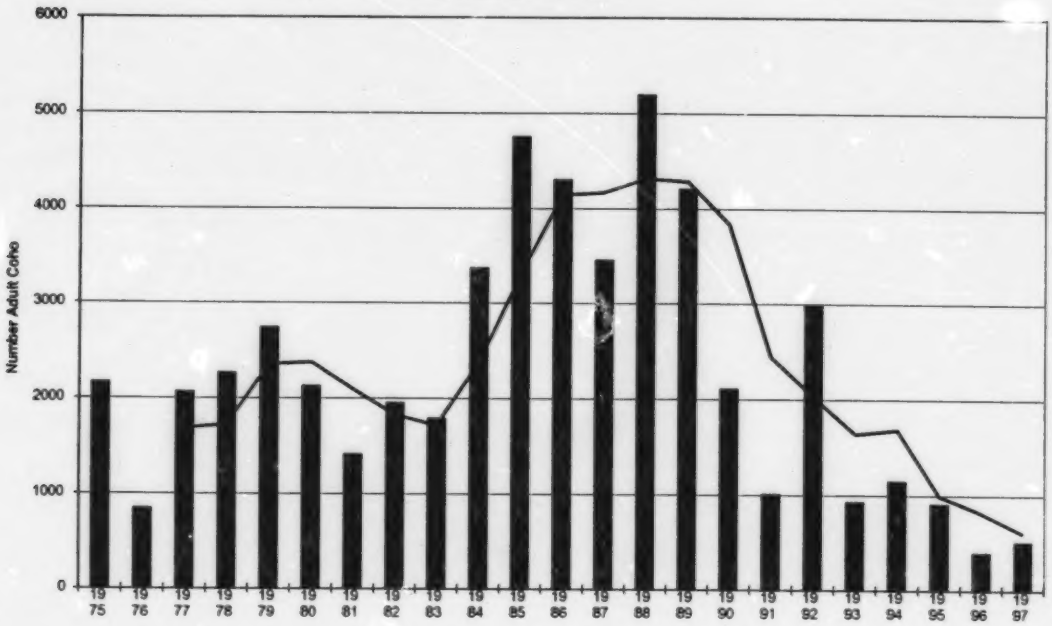


Fig. 4 Proportion of South Thompson Streams inspected with no coho escapement observed. Estimates (numbers of streams inspected each year indicated; trendline is a 3yr moving average)

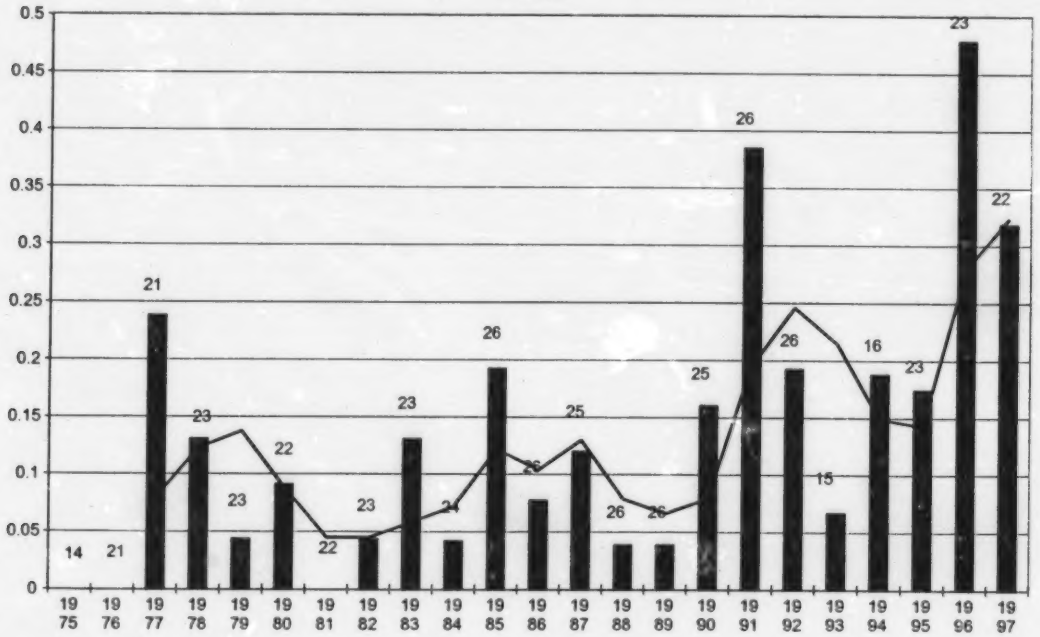
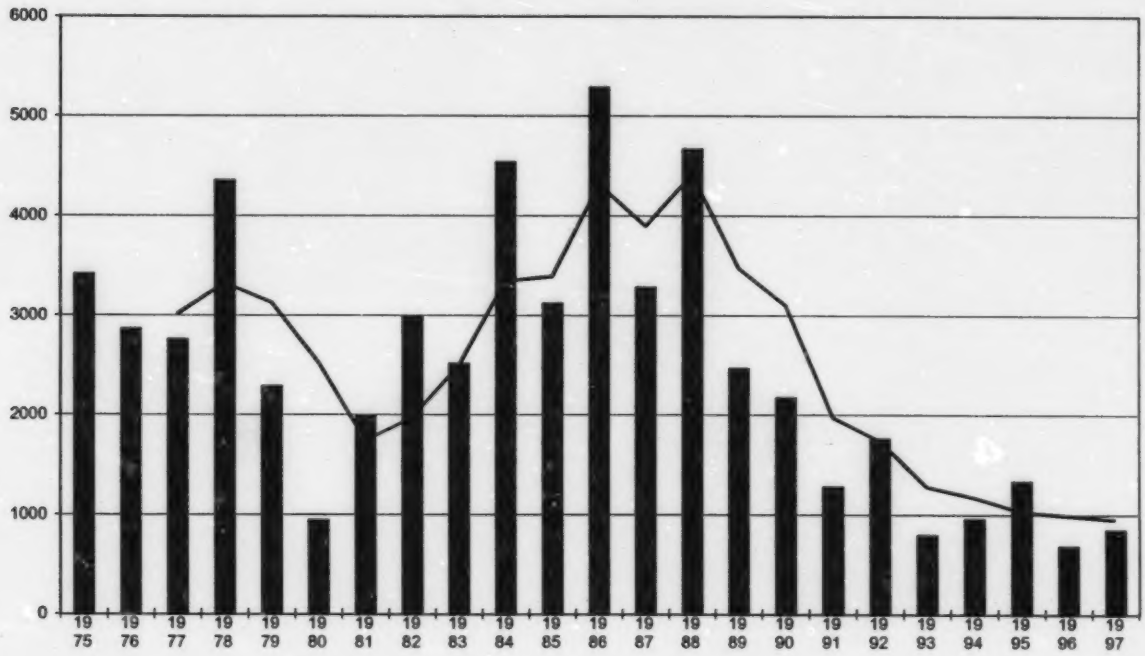


Fig. 5 Aggregate Coho Escapement to 10 North Thompson Streams (trendline is a 3yr moving average)



5. Appendix 1 Participants at the April 27-May 1, 1998 meeting of the Salmon PSARC Subcommittee.

Subcommittee Chair: Dave Peacock
PSARC Chair: Max Stocker

Subcommittee Members:

	Mon	Tues	Wed	Thurs	Fri
D. Anderson	✓	✓	✓	✓	✓
S. Argue		✓		✓	
D. Bailey	✓	✓	✓	✓	✓
A. Cass	✓	✓	✓	✓	✓
B. Holtby	✓	✓	✓	✓	✓
J. Irvine	✓	✓	✓	✓	✓
A. Tautz		✓			
R. Kadowaki		✓			
A. MacDonald		✓			
P. Ryall		✓	✓	✓	✓
M. Sullivan	✓	✓	✓	✓	✓
C. Wood	✓	✓	✓	✓	✓
D. Meerburg	✓	✓	✓	✓	
B. Riddell	✓	✓	✓	✓	
M. Bradford		✓	✓		

Observers:

	Mon	Tues	Wed	Thurs	Fri
R. Beamish	✓	✓	✓	✓	✓
L. Richards	✓	✓	✓		✓
R. McNicoll	✓	✓			
W. Leudke	✓				
S. Bachen	✓				
J. King	✓	✓	✓	✓	✓
D. Rutherford	✓	✓			
D. Nagtegaal	✓				
N. Schubert	✓	✓			
K. Simpson		✓			
R. Cook		✓			
R. Bailey		✓			
L. Jantz		✓	✓	✓	

Observers (Cont'd)

	Mon	Tues	Wed	Thurs	Fri
D. Ware		✓	✓		✓
S. Baillie		✓		✓	
K. Wilson		✓			
M. Folkes		✓	✓	✓	✓
R. Sweeting		✓	✓	✓	✓
T. Beacham	✓				
Z. Zhang			✓	✓	
S. McFarlane			✓	✓	
D. Noakes					✓
D. Welch				✓	✓

6. Appendix 2 Reviewers of Working Papers

No.	Title	Authors	Reviewers
S98-7	WCVI Coho Assessment	K. Simpson	L. Jantz
			D. Anderson
S98-8	Estimating the percentage of hatchery-reared juvenile coho salmon in the Strait of Georgia	R.J. Beamish R. Sweeting Z. Zhang	S. Lehmann A. MacDonald
S98-9	Forecasting coho marine survival using the regime concept	R.J. Beamish D. Noakes G.A. McFarlane W. Pinnex R. Sweeting J. King M. Folkes	D. Welch J. Steele B. Holtby
S98-10	Abrupt declines in the recreational catch of coho salmon in the Strait of Georgia in the 1990s are related to changes in climate.	R.J.Beamish G.A. McFarlane R. Thomson	R. Kadowaki K. Hyatt
S98-11	Rivers Inlet sockeye salmon: Stock status update.	D. Rutherford C. Wood S. McKinnell	P. Rankin S. Cox-Rogers
S98-12	A risk assessment for north coastal coho fisheries in 1998, with commentary on risk in southern inside and outside fisheries.	B. Holtby R. Kadowaki	B. Riddell R. Hillborn
S98-13	Stock assessment of Thompson River/ Upper Fraser River coho salmon	J. Irvine K. Wilson B. Rosenberger R. Cook	S. Argue J. Scott
S98-14	The use of trawl surveys to estimate pre-fishery juvenile anundance of coho salmon.	R.J.Beamish D. McCaughran M. Folkes R. Sweeting	N. Olsen D. Ware
S98-15	Stock status of Cowichan chinook salmon	D.A. Nagtegaal	W. Luedke

No.	Title	Authors	Reviewers
		B. Riddell	T. Gjernes
S98-16	Intra-annual changes in the abundance of coho, chinook and chum in Puget Sound in 1997.	R.J. Beamish M. Folkes R.Sweeting C. Mahnken	J. Fargo J. Irvine
S98-17	Dynamic change in proportion of hatchery-reared, wild ocean and stream type chinook in their first and second years in the Strait of Georgia.	Z. Zhang R.J. Beamish B.E. Riddell	P. Ryall C. Wood
S98-18	A risk assessment for Thompson River coho salmon.	M. Bradford	N. Schubert A. Cass R. Hillborn

7. Appendix 3 1998 West Coast Vancouver Island Chinook Forecast

PSARC held an extraordinary Steering Committee meeting by teleconference on April 16, 1998, to review the Salmon Subcommittee report on Somass River chinook terminal run forecast for 1998. The Steering Committee accepted the Subcommittee report and provided the following comments.

The Steering Committee concurs with the Subcommittee concern that the natural egg deposition of 13 million was well below the established minimum requirement of 50 million for the Somass River Chinook stock. The Steering Committee is concerned over the underescapement of this stock and recommends an extremely conservative pre-season planning and in-season management approach to avoid back to back years of very poor escapements. The relatively weak Age-3 returns to natural systems in 1997 is a further reason for a cautious approach in 1998.

The Steering Committee notes that given the weak age-2 returns, and the increased probability of low survivals of the 1996 and 1997 brood years (related to El Niño predation effects) the abundance of WCVI chinook will likely drop dramatically after 1998 and conservation concerns may persist for a number of years.

II. SALMON SUBCOMMITTEE REPORT

The PSARC Salmon Subcommittee met April 7, 1998 in Nanaimo. Those in attendance included: Don Anderson, Sandy Argue, Al Cass, Skip McKinnell, Dave Peacock (Chairperson) and Brian Riddell.

S98-6 Review of 1997 Terminal Run Formulation of Somass River Chinook, and Terminal Run Forecast for 1998. B. Riddell, W. Luedke, and J. Till.

Working Paper Summary

Based on returns through 1997 and using methods previously approved by PSARC, the recommended forecast for the total terminal run of chinook of Robertson Creek Hatchery and Stamp River chinook (age 3,4, and 5) to Barkley Sound in 1998, is 57,200±20% based on averaging the two forecast models. The age structure of the return is projected to be: 8.3% Age 3, 72.3% Age 4, and 19.3% Age 5; with an expected sex ratio of 51% females. The number of chinook required to meet the minimum spawning escapement goal is 32,300. This goal is achievable if ocean harvest rates are limited as in 1997 and the terminal harvest rate is controlled to be less than about 40%.

The detailed assessments and forecasts of the RCH/Stamp chinook are undertaken annually for management of that major stock plus as an indicator of the expected returns

to the naturally spawning chinook populations along the west coast of Vancouver Island. Terminal run size and spawning escapements to the RCH/Stamp indicator stock have been similar over the past three years and are projected to be similar and relatively weak again in 1998. However, returns to some of the natural systems were better in 1997 than indicated by this stock. This is particularly true for returns to populations along the northern half of the Island (Areas 25 to 27); seven populations in these Areas are, in aggregate, used in the Pacific Salmon Commission (PSC) to indicate trends in escapement to naturally-spawning chinook along the WCVI.

While this is positive indication that the conservation actions taken by Canada to protect these populations has been successful, there are two concerns which suggest caution when planning 1998 fisheries. First, the recovery in the northern population is not evident in the more southern naturally-spawning populations (e.g., the Area 24 populations and Nahmint River). Secondly, the age structure of the 1997 returns was strongly age-4 chinook. Returns of Age-3 chinook to the natural systems did not appear as strong as the return to the RCH/Stamp indicator stock. Consequently, returns in 1998 may be reduced if survival of the 1994 brood year declined again. The only indication of brood survival for these northern populations is the return to Conuma Hatchery. Age-3 returns in 1997 to Conuma were only about 25% of the Age-4 returns observed in the sport fishery and in the escapement.

While the condition of **most** naturally-spawning chinook populations along the WCVI have improved during recent years, the above concerns and the relatively weak return forecasted for the RCH/Stamp stock indicate a continued need for conservative 1998 management plans in fisheries impacting these stocks.

Subcommittee Discussion

The working paper uses methodologies previously reviewed and accepted by PSARC. It was noted by the author that an improvement to the PSC cohort analysis results in modest changes to the 1996 estimations. There was severe flooding in the fall of 1997 and escapement estimates are more uncertain, and may be underestimates. The forecast error increased to +/-20% as a result of poorer relative performance of recent forecasts. The forecasts were made during the period of abnormal ocean conditions between 1992 and 1995.

The Subcommittee discussed the merits of including further tables of historical data in this report. While this would be useful the information is available in PSARC document X96-01. The subcommittee noted that measures of forecast performance varied among all of the PSARC forecast papers this spring and a standardized approach would be preferred. In this paper the forecast performance has been good for all models and evaluation criteria are not an important issue. A standardized approach to reporting forecast uncertainty was also recommended consistent with the RMEC advice following the review of PSARC Advisory Document 98-2. The relative merits of reporting total predicted abundance versus terminal abundance were discussed. It was agreed in this case that

both total abundance and scenarios estimating predicted terminal abundance were appropriate to meet the needs of managers. Further clarification should be provided in the report to indicate the terminal forecasts are based on assumptions of ocean harvest. PSARC is not endorsing any specific ocean harvest scenario used to generate terminal run forecast examples. The paper does note, however, that the terminal run forecast will change depending on management decisions in non-terminal fisheries.

The Subcommittee is concerned that the natural egg deposition of 13 million was well below the established minimum requirement of 50 million. The paper shows the 2 year old abundance from the 1995 brood year is extremely poor. There are concerns that the 1996 brood was heavily impacted by mackerel in the summer of 1997. Current El Niño conditions in 1998 do not bode well for the survival of the 1997 brood. This combination of circumstances indicates that after the 1998 season WCVI chinook abundance is likely to drop dramatically again, and conservation concerns may persist for a number of years. Wild stock escapements to northern WCVI are well above recent averages, while the southern WCVI wild stock escapements are similar to recent years.

Subcommittee Recommendations

The Subcommittee recommends the paper and the forecast be accepted.